

SECTION 15455

~~HELIUM AND~~ NITROGEN SYSTEM TUBING & COMPONENTS GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section.

1.2 SUMMARY

- A. This Section includes piping and specialties for distribution of the following Process Gas systems operating at 200 psig (1380 kPa) and less:
1. Utility Nitrogen (N₂) ~~Note: If high purity nitrogen piping systems are required, they shall be 316L electro-polished stainless steel.~~
 2. High Purity Nitrogen
- B. This Section does not include the following:
1. Compressors, Receivers, Dryers, Storage, or any other equipment related to generating the Process Gases listed above.
 2. Piping for equipment related to generating the Process Gases listed above.
- C. Related Sections include the following:
1. Division 15 Section 15050 "Piping Systems".
 2. Division 15 Section 15052 "Brazing".
 3. Division 15 Section 15072 "Cleaning"
 4. Division 15 Section 15073 "Pressure Leak Testing".
 5. Division 15 Section 15074 "Mechanical Identification" for piping and specialty labels.

1.3 REFERENCES

- A. ~~PTFE: Polytetrafluoroethylene~~ ASTM Specifications:
1. ASTM A 262, Recommended Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steel
 2. ASTM A 269, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Use.
 3. ASTM A 370, Standard Methods and Definitions for Mechanical Testing of Steel Products.
 4. ASTM A 380, Standard Practice for Cleaning and Descaling Stainless Steel Parts, Equipment, and Systems
 5. ASTM A 450, Standard Specification for General Requirements for Carbon, Ferritic Alloy and Austenitic Alloy Steel Tubes
 6. ASTM A 632, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing (Small Diameter) for General Service
 7. ASTM A 700, Standard Practices for Packaging, Marking, and Loading Methods for Steel Products for Domestic Shipment

8. [ASTM F 1372, Test Method for SEM Analysis for Metallic Surface Condition for Gas Distribution System Components.](#)

B. [Federal Standards](#)

1. [Federal Standard No. 209, Cleanroom and Workstation Requirement, Controlled Environment](#)

C. [ANSI Standards](#)

1. [ANSI/ASME B46.1, Surface Texture.](#)
2. [ANSI Y14.5M, Dimensioning and Tolerancing.](#)
3. [ANSI/ASQC Z1.4, Sampling Procedures and Table for Inspection by Attributes.](#)

D. [SEMASPECS](#)

1. [SEMASPEC #90120391B-STD, Test Method for Determination of Helium Leak rate for Gas Distribution System Components.](#)
2. [SEMASPEC #90120403B-STD, Test method for XPS \[ESCA\] Analysis of Surface Composition and Chemistry of Electropolished Stainless Steel Tubing for Gas Distribution Systems Components.](#)

E. [EN Specifications](#)

1. [EN 10204, Inspection Documents for Metallic Products.](#)

1.4 SUBMITTALS

- A. Coordination Drawings: For Process Gas piping and specialties, including relationship to other services that serve same work areas, in 1/4" = 1'-0" scale.
- B. Detailed Schedules [and catalog cut information for proposed tubing and fittings.](#)
- C. Cleaning and testing procedures, and test results.
- D. Equipment Drawings: Manufacturer's drawings of filters, dryers, instruments, valves and other specialty items.

E. [Exposed procedure for cleaning fittings and accessories.](#)

F. [CGS Specifications](#)

1. [CGS G-4.1, cleaning of equipment for oxygen service.](#)

1.5 QUALITY ASSURANCE

- A. Provide listing/approval stamp, label, or other marking on equipment made to specified standards.
- B. Listing and Labeling: Provide equipment and accessories specified in this Section that are listed and labeled.
 1. Terms "Listed" and "Labeled": As defined in National Electrical Code, Article 100.
 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver and store cleaned and sealed tubing, valves and fittings in a clean and sheltered location.
- B. Label pipe, fittings, valves and specialties that have not been pre-cleaned or that have been pre-cleaned but have seal or packaging that is not intact, with temporary labels indicating that cleaning is required before installation. Cleaning and re-cleaning shall be paid for by the Contractor.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products by one of the following:
 - 1. Process Gases, General Duty Valves:
 - a. Valex Corp.
 - ~~a-b.~~ Nibco, Inc.
 - ~~b-c.~~ Parker Hannifin Corporation
 - ~~e-d.~~ Swagelok Company
 - ~~d-e.~~ Mueller Streamline ~~Watts~~ Regulator Company.

2.2 PIPING, GENERAL

- A. ASME Code Compliance: Provide Process Gases piping components complying with ASME B31.9, "Process~~Building Services~~Building Services Piping".

2.3 PIPES AND TUBES

- A. Copper Tube: ASTM B 88, Type L (~~ASTM B 88M, Type B~~), seamless, hard-drawn temper, cleaned for oxygen/electronic service, and nitrogen-purged at the factory per NFPA 9956F and sealed. Interior surface to be shiny bright with no interior discoloration.
- B. Stainless Steel Tube: Electropolished 316L Stainless Steel 1/8" to 3/8", ASTM A 632, seamless. 1/2" to 6", ASTM A 269, seamless up to 2".
 - 1. The 316L electropolished high purity gas piping shall be processed and tested in a class 100 certified cleanroom environment. The minimum purity of the test gas shall be 99.9995%. The deionized water shall have a resistivity of 18 Megohm-cm at 25°C.
 - ~~1. Hydrogen Service System shall be brazed. The use of threaded fittings for Hydrogen Service is not allowed.~~

2.4 PIPE AND TUBE FITTINGS

- A. Copper Tube Fittings: ASME B16.22, wrought copper or copper alloy, solder joint, pressure type, cleaned and bagged for oxygen/electronic service. Interior surface to be shiny bright with no interior discolorations.
- B. Bronze Tube Flanges: ASME B 16.24, Classes 150 and 300.
- C. Transition Fittings: Type, Material, and end connections to match pipe being joined.
- D. Stainless Steel Fittings: ASTM A269, butt weld.

2.5 JOINING MATERIALS

- A. Refer to Division 15 Section 15050 "Piping Systems" for joining material not in this section.

2.6 VALVES

- A. General-Duty Valves: Refer to Division 15 Section 15100 "Valves" for Process Gases service valves not specified in this Section and for valves for other fluids.
- B. Special-Duty, Process Gases Valves: Include PTFE seats and comply with the following:
1. Ball Valves, 2 Inch NPS (DN 50) and Smaller: MSS SP-110; 3 piece bronze body with blowout-proof stem, full port; stainless steel ball; threaded ends; and 600 psig (4140 kPa) minimum WOG pressure rating.
 2. Butterfly Valves, 2½ Inch NPS (DN 65) and Larger: MSS SP-67; Type I (bubble tight); single flange (lug type), cast iron body with ductile iron disc, and 200 psig (1380 kPa) minimum WOG pressure rating.
 3. Check Valves, 2 Inch NPS (DN 50) and Smaller: MSS SP-80; Type 4 or non-standard T-pattern, swing check; Class 125, bronze body with composition-to-metal seat and threaded ends.
 4. Check Valves, 2½ Inch NPS (DN 65) and Larger: MSS SP-71, Type II full-waterway or Type IV clear-waterway, cast iron body with composition-to-metal seat and flanged ends.
 5. Globe Valves, 2 Inch NPS (DN 50) and Smaller: MSS SP-80, Class 125, Type 2, bronze body with composition-to-metal seat and threaded ends.

C. High Purity Piping Valves

1. Configuration: Ball valve fitted with tube stubs or compression fitting ends
 - a. Materials of Construction:
 - 1) Wetted Path: 316L stainless steel
 - 2) Non-Wetted Path: 300 – series stainless steel, vinyl (handle sleeve), tamper-evident ink (on bolt threads).
 - 3) Standard seats/seals: Reinforced Teflon (RTFE)seats, virgin Teflon (PTFE) seals. Other seat/seal materials are available.
 - 4) ¼" o.d. to 6" o.d. (6.4 mm o. d. to 152.4mm o.d.)
2. Material Characteristics:
 - 1) ASTM Reference:
 - i ¼" to 3/8" (6.4 mm to 9.5mm) tube stubs: ASTM A632
 - ii ½" to 6" (12.7mm to 152.4mm) tube stubs: ASTM A269
 - iii ½" to 6" valve, cast bodies: ASTM A351-CF8M stainless steel
 - iv ½" to 6: valve, cast flanges: ASTM A351-CF3M stainless steel
3. Manufacturing Method
 - 1) Tube Stub: ¼ " to ½" (6.4mm to 12.7mm): Seamless. > ½" (12.7mm): Welded.
 - 2) Body and Endcap Flange: Cast
4. Tube Stub Sulfur Content:
 - 1) Seamless tube stub: .005 to .012%
 - 2) Welded tube stub: .005 to .017%

2.7 SPECIALTIES

- A. Safety Valves: ASME boiler and Pressure Vessel Code, Section VIII, "Pressure Vessels" construction, National Board certified, labeled, and factory sealed; constructed of bronze body with poppet safety valve for compressed air service.
 - 1. Pressure Settings: Higher than discharge pressure and same or lower than receiver pressure rating.
- B. Pressure Regulators: Bronze body, direct acting, spring loaded manual pressure setting adjustment, and rated for 250 psig (1725 kPa) inlet pressure, except where otherwise indicated.
 - 1. Type: Diaphragm operated.
 - 2. Type: Pilot operated.
- C. Pressure Regulators: Aluminum alloy or plastic body, diaphragm operated, direct acting, spring loaded, manual pressure setting adjustment, and rated for 250 psig (1725 kPa) inlet pressure, except where otherwise indicated.
- D. High Purity Nitrogen Filters:
 - 1. Filtration to a 0.01 micron.
 - 2. Filter Housing: 316L electropolished stainless steel.
 - 3. Joints: TIG welded. Viton o-ring seal.
 - 4. Filter material PTFE.
 - 5. Manufacturer: Pall or approved equal.
 - 6. Filter Housing model type: HPL>
 - 7. Filter model type: Emflon Filter
- E. Hoses, Clamps, and Couplings: Provide compatible hose, hose clamps, and hose couplings, suitable for Process Gases service, of nominal diameter, and rated for 300 psig (2070 kPa) minimum working pressure, except where otherwise indicated.
 - 1. Hose:
 - 2. Hose Clamps: Stainless steel

2.8 HIGH PURITY PIPING TESTING AND INSPECTION

- A. General: Testing and inspection plans correspond to acceptable quality level of 0.30% per ANSI/ASC Z1.4
- B. Visual Inspection: Interior surfaces are inspected with the unaided eye and compared to the manufacturer's Library of Parts for this product line.
- C. Surface Roughness Measurement: Interior surfaces measured with a stylus-type measuring device in accordance with ASME B46.1. A sampling of middles of tubes are checked to ensure process consistency.
 - 1. Sampling Length Cutoff: 0.030" (0.762mm)
 - 2. Transvers Length: 0.150" (3.81mm)
- D. Leak Testing: All fittings containing circumferential welds are inboard-helium-leak tested to 1×10^{-9} atm cc/s He.

E. Scanning Elector Microscopy (SEM): SEM photographs of finished interior surfaces are analyzed on a assize and mill heat basis per ASTM F 1372.

1. Maximum number of defects: 40 in a 3500 ± 100X field of view.

F. Particle Testing:

1. Sample size: one length of cleaned and packaged tube from each heat and size.

2. Acceptance Criteria: < 5 particles per cubic foot = 0.1 microns, and zero particles per cubic food - .3 microns.

G. Moisture Testing:

1. Sample size: one length of cleaned and packaged tube from each heat and size.

2. Acceptance Criteria: addition of less than 0.5ppm moisture to nitrogen gas.

2.9 HIGH PURITY PIPING PAGKAGING

A. Purging Prior to Capping: UHP nitrogen.

B. Capping:

1. 1/8" to 4" (3.18mm to 101.6mm): Polyethylene cap over a 1.75-mil (.044mm) polyamide film

2. 6" (152.4mm): Vinyl cap over a 1.75-mil (.044mm) polyamide film.

C. Bagging:

1. 1/8" to 3/4" (3.18mm to 19.1mm): 4-mil (.102mm) polyethylene inner sleeve, 6-mil (.152mm) polyethylene outer sleeve.

2. 1" to 6" (25.4 mm to 152.4mm): 6-mil (.152mm) polyethylene inner and outer sleeve.

3. 1/8" (3.18mm) tube packaged two per bag.

D. Shipping Container: Packaged for shipment in such a manner which prevents damage to product and primary-product packaging.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. ASME Code Compliance: Provide Process Gases piping components complying with the following:

1. Process Gases Piping: ASME B31.9, "Building Services Piping".

B. Install flanges, union, transitions and special fittings, and valves with pressure ratings same or higher than system pressure rating used in applications below, except where otherwise specified.

C. Utility Process Gases Distribution Piping: Use the following:

1. 1½ Inch NPS (DN 40) and Smaller: Copper tube, copper tube fittings, Class 300 bronze tube flanges, and brazed and flanged joints.

2. 2 to 4 Inch NPS (DN 50 to DN 100): Copper tube, copper tube fittings, Class 300 bronze tube flanges, and brazed and flanged joints.

3.2 VALVE APPLICATIONS

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
1. Shut-off Duty : Use ball or butterfly valves.
 2. Throttling Duty: Use globe or butterfly valves.
 3. Process Gases Supply to Equipment: Locking handle, safety exhaust ball valves.

3.3 PIPING INSTALLATION, GENERAL

- A. Refer to Division 15 Section "~~Basic Mechanical Materials and Methods~~Piping Systems" for basic piping installation.
- B. Install eccentric reducers where pipe is reduced in size in direction of air flow, with bottoms of both pipes and reducer flush.
- C. Connect branch air to mains from top of main. ~~Provide drain leg and drain trap at end of each main, branch, and low point in piping.~~
- D. Install supports and anchors according to Division 15 Section 15050 "Piping Systems". Do not exceed the following spacing between pipe hangers:
1. Copper Tube: For the following sizes:
 - a. 1¼ Inch NPS (DN 32) and Smaller: 6 feet (1.8 m) horizontal and 10 feet (3 m) vertical.
 - b. 1½ Inch NPS (DN 40) and Larger: 10 feet (3 m) horizontal and 10 feet (3 m) vertical.
- E. Install valves according to Division 15 Section "Valves".
- F. Install expansion joints and anchors according to Division 15 Section 15050 "Piping Systems".
- G. Install thermometers and pressure gauges according to Division 15 Section 15950 "Direct Digital Controls Systems".

3.4 NITROGEN GAS STAINLESS STEEL TUBING INSTALLATION

A. Inspection and Cleaning Room:

1. A receiving area for initial material inspection will be provided. Inspect all material for specification conformance in this designated area. A Class 1,000 material cleaning room will be supplied by the Contractor or erected by the Contractor on site with sufficient air handling system to supply a minimum of 30 air changes per hour. The room will have Class 100 laminar flow work areas. Cleaning room will be able to store sufficient "cleaned" material for two days work.
2. Provide 0.02 micron filtered Argon or nitrogen from a cryogenic source. Moisture content shall be less than 2 ppm, oxygen shall be less than 3 ppm. Total hydrocarbon shall be less than 0.2 ppm. Provide cleaning materials consisting of stainless steel pans with lids, 18 mega-ohm hot DI water and Texwipes, powder free and solvent compatible Class 100 cleanroom gloves. Kimwipes, polyethylene bags of various sizes and approved footwear and smocks.

3. Only qualified and trained personnel will be allowed in the cleaning room. Contractor and employee qualification to be by Owner or Owner's representative. Worktables and work tools shall be cleaned daily with 18 mega-ohm hot DI water. Provide stainless steel or plastic racks for storage of material. No material will be stored on the floor.
4. Utilize specified protocol for gowning and disposal of cleanroom clothing for all personnel during all inspections, cleaning and assembling procedures.

B. Inspection

1. An area shall be designated on site to receive all high purity gas components. It shall be well-lighted and provide storage off ground. There shall be controlled and limited access to this area.
2. One hundred percent of all components shall be inspected in this area prior to installation. Cause for rejection can include, but not be limited to, damaged packing, dented surfaces, inappropriate identification and any other condition that does not otherwise conform to the specifications listed here. No attempt will be made to reclean any valves that have rejected which will be replaced by the contractors at their costs.

C. Cleaning

1. After tubing has been cut to length, faced and deburred, clean tubing by blowing a lint-free swab soaked in filtered 18 mega-ohm DI water through the tube using filtered (0.02 micron) cryogenic grade argon or nitrogen that is certified to contain less than 2 ppm moisture, 0.2 ppm hydrocarbon and 5 ppm oxygen. Use cleaning "pigs" made from Kimwipes and tied to Teflon tape or nylon string, then wrapped with a Texwipe for this step. Cleaning "pig" dimension should be 3:1 (length to diameter ratio). Inspect the wipes after each shot with a magnifying glass using a bright light for visible discoloration or metal particles contamination. If clean, proceed with the next step. If contamination is present, repeat step until wipe is clean. If more than 5 cycles is needed, reject tube. After tube has been cleaned, rinse the tube with 18 mega-ohm DI water to remove any possible lint from the cleanroom wipes. Blow the tube dry with 0.02 micron filtered argon and nitrogen from a cryogenic source and bag the ends under a slight positive pressure. Tape the bags at least 3 inches from the end of the tubing. If tubing loses this bagging prior to installation, it shall be recleaned according to this specification. Label each cleaned piece with date and time of cleaning.
2. Clean all fitting and components in the same manner as the tubing.
3. All workers will wear protective clothing and gloves while in the cleaning room.
4. Clean only enough tubing that can be installed within 48 hours. Cleaned tubing will not be allowed to be stored more than 48 hours without an inert gas purge that is backed up by a dewar with at least 5 psig on the system. If tubing stands longer than this, it shall be recleaned and bagged according to this specification.

D. Piping Installation

1. Methodology: Process tubing to be provided in maximum continuous lengths. Use full and continuous lengths of tubing between fittings whenever possible. Avoid extra joints. Use only reduction fittings where changes in sizes occur.

2. Cutting: All cutting and burr removal shall be done outside of the cleanroom envelope. Clean outside of tube to be cut with a nylon abrasive pad sufficiently for a joint area on each side of the intended cutoff point.
 - a. Use tube cutter with sharp stainless steel wheel, free from oil or grease, and dedicated to use on stainless steel tubing only.
 - b. No cutting oils or grease shall be used at any time.
 - c. Make cuts with edges true and square.
 - d. Remove burrs with stainless steel deburring tools dedicated for use on stainless steel tube.
 - e. Use purge gas to remove any chips.
 - f. The above procedures apply to new cuts.
 - g. Reclean any tubing that has been cut.
3. Fabrication: Piping system shall be fabricated in subassemblies to the maximum extent possible.
 - a. No sharp edges or protrusions shall be permitted inside the tube except weld protrusions.005 inch or less.
 - b. Support assembly to maintain proper tubing alignment allowing for sufficient clearance around joints to be welded.
4. Welding: Use an automatic orbital tungsten inert gas (TIG) arc welding machine, ARC machines or equal. Shielding gas shall be argon.
 - a. All welds shall be fusion welds with 100 percent penetration.
 - b. All welded joints which show evidence of overheating, lack o f fusion, incomplete penetration, undercut, cracking, pinholes, or other defects of fit-up or workmanship shall be replaced at the sole discretion of the Owner's Representative.
 - c. Discoloration of the weld inside the tube is not permitted and such welds shall be unacceptable.
 - d. No welding shall be done within 6 inches of an open end. Use extensions if necessary.
5. Weld Inspection: All welds will be inspected daily by the Owner's Representative. The Owner's Representative may reject any welds that do not match accepted "coupons".
6. Pipe isolators: Resiliently isolate all piping from points of contact such as supports.
7. Pipe Support Spacing: Install support within 12 inches of each change of direction and for each branch 3 feet or longer.
8. Horizontal Support Spacing:

<u>Material</u>	<u>Size</u>	<u>Center-to-Center Maximum</u>
<u>Steel</u>	<u>1-inch to 2-inch</u>	<u>8 feet</u>

9. Purging:
 - a. Provide an argon purge station consisting of analyzed argon dewars, stainless steel regulators and 0.02 micron filters which are consistent with this specification. Provide a manifold with a minimum of two dewar supplies. The purge station will utilize bellows sealed valves consistent with this specification, Electropolished tubing and virgin cleaned "PolyFlo" tubing. The purge station will be cleaned and assembled according to procedures outlined in this specification.

- b. Each system will be purged from one point with 0.02 micron filtered argon. The filters will be added to each system at the purge port of a valve. Each system will have a continuous or block purge of argon at all times.
- c. As each cleaned and bagged appurtenance is added to the system, a minimum of 3 to 5 minutes will be required to purge the joint to be welded. (Use a minimum of five minutes for tubing over one inch in diameter.) This time will be established by using a trace oxygen analyzer. Continue purge until analysis indicated not more than 2 ppm moisture, 3ppm oxygen and .5ppm total hydrocarbon. A minimum purge rate of 10 to 25 SCFH is required with only one exit of the purge gas allowed. A purge restrictor will be used at the end of the pipe being welded to adjust purge gas flow and maintain positive pressure. At all times use sufficient purge flow to prevent oxidation or discoloration on the inside of the tube. Post-purge duration should be a minimum of 3 to 5 minutes.
- d. Temporary compression fittings may be used to seal open ends of the tube of fittings during construction to minimize and control the use of argon. Use stainless steel compression caps with Teflon or nylon ferrules cleaned to this specification. Use non-coated stainless steel nuts for these temporary caps. Do not use molybdenum coated materials.
- e. If a tube or component has lost it's purge prior to installation, it must be returned to the cleanroom and be recleaned.
- f. Use argon from a cryogenic source with an analysis of not more than 1 ppm moisture, 1ppm oxygen and 0.2 ppm total hydrocarbon for the purge. Do not use welding grade argon. Use 1.02 micron filtered argon for the exterior purge. Use a filter at the effluent side of the welding machine for this purpose. A dewar should also be used for this source. Under no circumstance should the interior of the tube be purged through the welding machine. At the tubing installer's option, welding grade argon with point-of-use purification achieving at least electronic grad argon may be utilized.

3.43.5 JOINT CONSTRUCTION

A. Utility Process Nitrogen

- 1. Copper tubing shall be brazed.

~~A. Refer to Division 15 Section 15050 "Piping Systems" for basic piping joint construction.~~

~~B. Grooved-End, Mechanical Coupling Joints: Follow grooved-end mechanical coupling manufacturer's written instructions.~~

~~C. Press-Sealed Joints: Follow press-seal fitting manufacturer's written instructions.~~

- D.2. Dissimilar Material Piping Joints: Make joints using adapters compatible with both piping materials.

B. High Purity Nitrogen:

- 1. Stainless steel tubing shall be automatic orbital TIG welded.

3.53.6 CONNECTIONS

- A. Install piping next to equipment and accessories to allow service and maintenance.

- B. Connect nitrogen air piping to equipment and accessories with flanges unions and shut-off valves. Install with filters strainers where indicated.
 - 1. Install thermometers where indicated.
 - 2. Install pressure gages where indicated.
- C. Install specialties as indicated.

3.63.7 FIELD QUALITY CONTROL

- A. Test and adjust piping safety controls. Replace damaged and malfunctioning controls.
- B. Piping System Tests: Test new and modified parts of existing piping. Cap and fill Process Gases piping with oil-free, dry air, or gaseous nitrogen filtered argon or nitrogen to pressure of 50 psig (345 kPa) above system operating pressure, but not less than 150 psig (1035 kPa). Isolate test source and let stand for 4 hours to equalize temperature. Refill system, if required, to test pressure and hold pressure for 2 hours with no drop in pressure.
 - 1. Repair leaks and defects with new materials and re-test system until satisfactory results are obtained.

3.73.8 COMMISSIONING

- A. Perform the following final checks before startup.
 - 1. Verify that specified test of piping are completed.
 - 2. Check for piping connection leaks.
 - 3. Check for proper seismic restraints.

END OF SECTION